Cost-effectiveness of colonoscopy in screening for colorectal cancer
Sonnenberg A, Delco F, Inadomi J M

Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
Three screening strategies for colorectal cancer (CRC) were assessed in the study. These were faecal occult blood testing (FOBT), flexible sigmoidoscopy, and colonoscopy.

Type of intervention
Screening.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised persons of 50 years of age in the general population.

Setting
The setting of the study was not stated. The economic study was carried out in the USA.

Dates to which data relate
The effectiveness and resource use data were derived from evidence published from 1979 to 1999. The price year was 1998.

Source of effectiveness data
The effectiveness evidence was derived from published studies, supported by the authors’ assumptions.

Modelling
A decision model based on a Markov process was used to model the total costs and effectiveness of the three screening strategies. The timeframe of each cycle was one year. The model referred to a hypothetical population of 100,000 persons aged 50 years. If the annual FOBT is negative, patients have to wait for the next annual test and if positive, patients are referred to colonoscopy. In the case of normal colonoscopy, annual FOBT is resumed after 10 years, while in the case of an adenomatous polyp, surveillance colonoscopy is repeated every 3 years until the adenomatous polyps disappear. For 5-year flexible sigmoidoscopy, the model is similar to that for FOBT. In the case of colonoscopy, the model is similar to the previous ones, except that all the states associated with a screening test other than colonoscopy are eliminated. Those patients who declined scheduled tests entered the state of non-compliance. Three types of non-compliance were considered: screened patients must be compliant with the initial procedure, each repeated screening, and colonoscopy after a positive result on FOBT or flexible sigmoidoscopy. Patients could move to the state of CRC in any cycle.
Outcomes assessed in the review
The outcomes assessed in the review and used as model inputs were:

the sensitivity and specificity of FOBT;
the screening interval for FOBT;
the percentage of adenomas found by sigmoidoscopy;
the annual incidence of adenomas;
the screening interval for sigmoidoscopy;
the surveillance interval after polypectomy;
the efficacy of colonoscopy in preventing CRC;
the bleeding rate with colonoscopy or polypectomy;
the perforation rate with colonoscopy, polypectomy or sigmoidoscopy; and
the mortality rate from CRC.

Study designs and other criteria for inclusion in the review
Not reported.

Sources searched to identify primary studies
Not stated.

Criteria used to ensure the validity of primary studies
Not reported.

Methods used to judge relevance and validity, and for extracting data
Not reported.

Number of primary studies included
The effectiveness evidence was derived from 18 published studies.

Methods of combining primary studies
The primary studies were combined using a narrative method.

Investigation of differences between primary studies
Not carried out.

Results of the review
The sensitivity of FOBT was 40% (range: 20 - 60) and the specificity was 97.50% (range: 70 - 99).
The screening interval for FOBT was 1 year (range: 1 - 3).
The percentage of adenomas found by sigmoidoscopy was 45%.

The screening interval for sigmoidoscopy was 5 years (range: 3 - 10).

The annual incidence of adenomas was 1% (range: 0 - 6).

The screening interval for colonoscopy was 10 years (range: 3 - 10).

The surveillance interval after polypectomy was 3 years (range: 1 - 5).

The efficacy of colonoscopy in preventing CRC was 75% (range: 50 -100).

The bleeding rate was 0.15% with colonoscopy and 2% with polypectomy.

The perforation rate was 0.20% with colonoscopy, 0.38% with polypectomy, and 0.011% with sigmoidoscopy.

The mortality rate from CRC was 40%.

Methods used to derive estimates of effectiveness
The authors made an assumption in order to model the effectiveness evidence.

Estimates of effectiveness and key assumptions
The authors assumed that the compliance rate was 100% in the base-case.

Measure of benefits used in the economic analysis
Several outcomes were obtained from the decision model. These included the number of cases of CRC prevented (expressed as a number and as a percentage of the total number of CRC cases), the life-years saved, the reduction in mortality, the number of procedures, and complications. The main benefit measure used in the economic analysis was the number of life-years saved, which was discounted at a rate of 3%.

Direct costs
A 3% discount rate was used as the lifetime costs were calculated. The unit costs were reported, but the quantities of resources used were not given clearly given. The health costs included in the analysis were those for the three screening strategies, polypectomy, and the management of bleeding and perforation. These also took account of visits to the emergency room, hospitalisation and diagnostic tests. The cost/resource boundary was that of the third-party payer. The estimation of the resource use was derived from the literature. The costs were estimated from both actual data (DRG reimbursement rates) and published studies. The 1998 fiscal year was used for the estimation of the costs.

Statistical analysis of costs
No statistical analysis of the costs was carried out.

Indirect Costs
The indirect costs were not included in the analysis.

Currency
US dollars ($).

Sensitivity analysis
Sensitivity analyses were carried out to assess the robustness of the estimated cost-effectiveness ratios to variations in the baseline assumptions and values. In the first multi-way analysis, the frequency of colonoscopy was increased from once every 5 years, its efficacy was reduced to 50%, and compliance with repeated colonoscopy was reduced to 80% (worst scenario for colonoscopy). In further one-way sensitivity analyses, all the baseline effectiveness values in the model were changed within the ranges reported above.

**Estimated benefits used in the economic analysis**

The number of cases of CRC prevented was 926 with FOBT, 2,027 with sigmoidoscopy, and 4,428 with colonoscopy.

The number of CRC cases prevented expressed as a percentage of the total number of CRC cases was 16% with FOBT, 34% with sigmoidoscopy, and 75% with colonoscopy.

The number of life-years saved was 1,896 with FOBT, 3,636 with sigmoidoscopy, and 7,952 with colonoscopy.

The reduction in mortality was 18% with FOBT, 34% with sigmoidoscopy, and 75% with colonoscopy.

In terms of complications, there were 234 bleeding events with FOBT, 313 with sigmoidoscopy, and 1,224 with colonoscopy. There were also 152 screening-related perforations with FOBT, 81 with sigmoidoscopy, and 797 with colonoscopy. Finally, there were 7 screening-related deaths with FOBT, 3 with sigmoidoscopy, and 37 with colonoscopy.

**Cost results**

The total costs were $154,853,577 in the FOBT model. These comprised $5,497,809 for FOBT, $33,640,016 for colonoscopies, and $115,715,753 for care for CRC.

The total costs were $269,214,301 in the sigmoidoscopy model. These comprised $163,313,218 for sigmoidoscopies, $16,281,508 for colonoscopies, and $89,619,575 for care for CRC.

The total costs were $154,853,577 in the colonoscopy model. These comprised $189,667,598 for colonoscopies and $34,113,230 for care for CRC.

In the case of no screening programme, the total costs of care for CRC would be $136,452,922.

**Synthesis of costs and benefits**

In the incremental analysis, the additional cost per extra life-year saved was $9,705 for FOBT over no screening. Colonoscopy dominated sigmoidoscopy, and offered an additional cost per extra life-year saved of $11,382 over FOBT.

The results from the sensitivity analyses indicated that the incremental cost-effectiveness ratio of colonoscopy was $54,561 in the worst scenario.

All of the estimated cost-effectiveness ratios were sensitive to variations in the compliance rates, especially FOBT, due to the higher frequency of the screening. However, the cost-effectiveness ratios were robust to variations in the other assumptions and values used in the base-case analysis.

**Authors’ conclusions**

The authors concluded “Colonoscopy represents a cost-effective means of screening for colorectal cancer because it reduces mortality at relatively low incremental costs. Low compliance rates render colonoscopy every 10 years the most cost-effective primary strategy for colorectal cancer”.

**CRD COMMENTARY - Selection of comparators**

The rationale for the choice of the comparators was clear. The three interventions were selected as representing...
screening strategies currently used and recommended for the detection of CRC. You should assess whether they are currently implemented in your own setting.

Validity of estimate of measure of effectiveness
The analysis of effectiveness mainly used published studies but a formal review of the literature was not undertaken. The authors did not state whether they took into account differences in the primary studies, or if a weighting scheme was used to reflect differences in the sample sizes. In addition, the authors made an assumption in the model, but possible variability was appropriately tested in the sensitivity analyses. The comparator for colonoscopy was no screening. However, in an incremental analysis, the comparator should be the next best technology, which, in the base-case, was FOBT.

Validity of estimate of measure of benefit
The benefit measure used in the economic analysis was the number of life-years saved with the three screening strategies. This appears to have been appropriately modelled. In addition, it adequately represented the outcome of the programmes. Accounting for individual preferences over quality of life issues would have improved the analysis. A 3% discount rate was used.

Validity of estimate of costs
The analysis of the costs was carried out from the perspective of the third-party payer in the USA. It appears that all the categories of costs have been included in the analysis. The unit costs were generally reported, although the costs were treated deterministically and no sensitivity analyses were carried out. The price year was reported and appropriate discounting was carried out.

Other issues
The authors made some comparisons of their findings with those from other studies, although the issue of the generalisability of the study results to other settings was not explicitly addressed. However, several sensitivity analyses were carried out (although not on cost inputs), thus enhancing the external validity of the analysis. The study population comprised unselected patients, and therefore, the study results appear to be generalisable to the general public in the USA. The authors reported some limitations of their study. These were mainly related to the assumptions made in the decision model and the lack of indirect costs.

Implications of the study
The authors claimed that colonoscopy was cost-effective. However, although it was shown to be the most effective strategy, it was also the most expensive. Whether it is cost-effective depends on the opportunity cost. This is the loss in benefit from not allocating resources/funds to any technology (or technologies) due to these resources/funds being directed to colonoscopy.

Source of funding
Supported by a grant from the Centers for Disease Control and Prevention, the Swiss Foundation for Grants in Medicine and Biology, and an American College of Gastroenterology Faculty Development Award.

Bibliographic details

PubMedID
11033594